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R.C. Herndon, J.E. Moerlins, C.M. Teaf, V.W. Lambou, J.D. Koutsandreas

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Center for Biomedical & Toxicological Research & Hazardous Waste Management, Florida State University, Tallahassee, Florida; U.S. Environmental Protection Agency, P.O. Box 93478, Las Vegas, NV 89193-3478; U.S. Environmental Protection Agency, Washington, D.C.

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16. ABSTRACT

As a result of recent legislation, the United States Environmental Protection Agency must evaluate the potential impact of small quantity generator hazardous waste on groundwater contamination in the United States. In particular, this evaluation is to focus on potential groundwater contamination due to small quantity generator hazardous waste disposal in municipal sanitary landfills. We have analyzed the data collected from approximately 20,000 small quantity hazardous waste generators located within all of the 67 counties in the State of Florida (U.S.A.). The data link types and quantities of hazardous waste generated as well as the hazardous waste management methods used to the specific industries producing the waste. The State of Florida is relatively large in size and is diverse in terms of individual county population size and growth, economic profile, and environmental vulnerability to groundwater contamination. As such, these Florida data provide a useful representation of the hazardous waste generation and management practices os small quantity generators in the United States. The small quantity generator hazardous waste study described in this article has identified the types of waste which pose a potential threat to groundwater in the State of Florida.

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HAZARDOUS WASTE FROM SMALL QUANTITY GENERATORS IN THE UNITED STATES

R.C. Herndon[1], J.E. Moerlins[1], C.M. Teaf[1], V.W. Lambou[2], and J.D. Koutsandreas[3]

[1]Center for Biomedical & Toxicological Research and Hazardous Waste Management, Florida State University, Tallahassee, Florida (U.S.A.)

[2]U.S. Environmental Protection Agency, Las Vegas, Nevada (U.S.A.)

[3]U.S. Environmental Protection Agency, Washington, D.C. (U.S.A.)

SUMMARY

As a result of recent legislation, the United States Environmental Protection Agency must evaluate the potential impact of small quantity generator hazardous waste on groundwater contamination in the United States. In particular, this evaluation is to focus on potential groundwater contamination due to small quantity generator hazardous waste disposal in municipal sanitary landfills. We have analyzed the data collected from approximately 20,000 small quantity hazardous waste generators located within all of the 67 counties in the State of Florida (U.S.A.). The data link types and quantities of hazardous waste generated as well as the hazardous waste management methods used to the specific industries producing the waste. The State of Florida is relatively large in size and is diverse in terms of individual county population size and growth, economic profile, and environmental vulnerability to groundwater contamination. As such, these Florida data provide a useful representation of the hazardous waste generation and management practices of small quantity generators in the United States. The small quantity generator hazardous waste study described in this article has identified the types of waste (e.g., solvents, photofinishing wastes, and waste oils and lubricants) which pose a potential threat to the groundwater in the State of Florida. Systematic risk assessments have been performed for over 40 of the components of these waste streams in order to better quantify the potential environmental or human health hazard posed by small quantity generator wastes disposed in sanitary landfills.

INTRODUCTION

Recent legislation in the United States requires that the United States Environmental Protection Agency (U.S. EPA), in order to protect human health and the environment, must evaluate the potential impact of small quantity generator hazardous waste on groundwater quality in the United States. Small quantity generators are defined in Chapter 40, Part 260.10 of the U.S. Code of Federal Regulations as generators that produce less than 1,000 kilograms of hazardous waste in a calendar month. In particular, this evaluation is to focus on the potential for groundwater contamination due to small quantity generator hazardous waste disposal in municipal sanitary landfills. Information on the types and quantities of hazardous waste that typically are deposited in these facilities is important in order to properly design monitoring systems to detect groundwater

contamination. Once the types and quantities of this small quantity generator hazardous waste are identified, it is important to evaluate the toxicological risks associated with human exposure to the chemical compounds contained in the leachate that may contaminate public and private drinking water. We have conducted risk assessments for over 40 compounds that include many typical constituents of small quantity generator hazardous waste streams, and have assessed the risks posed by these contaminants, based on a review of the available human, animal and aquatic toxicological data. It is clear that for many compounds that are of significant interest, there is a paucity of animal or human toxicological data. This lack of animal and human toxicological data makes it particularly difficult to assess the long-term, chronic effects of exposure to drinking water contaminated with many of these compounds.

STUDY AREA

In this study we have analyzed the data collected from approximately 20,000 small quantity hazardous waste generators located within all of the 67 counties in the State of Florida (ref. 1). The State of Florida (Fig. 1) is relatively large in size, and is diverse in terms of individual county population size and growth, economic profile, and environmental vulnerability to groundwater contamination. As such, these data provide a useful representation of the hazardous waste generation and management practices of small quantity generators in the United States. These data have been collected from firms and agencies engaged in agriculture, forestry, construction, manufacturing, transportation and utilities, wholesale trade, retail trade, service industries, and governmental services. The data link the types and amounts of hazardous waste generated, as well as hazardous waste management methods used (including the

Fig. 1. Map showing study area (State of Florida) relative to the United States.

disposal of hazardous waste in municipal landfills) to the specific industries producing the waste. The small quantity hazardous waste data were collected at the county level, and all of the 67 counties in the State of Florida are included in the data base.

DATA COLLECTION AND ANALYSIS

The data contained in this paper on hazardous waste generation, management, and sanitary landfills were collected as part of the Florida Local Government Hazardous Waste Management Program. A major goal of this Florida Local Government Hazardous Waste Management Program is to address the problems associated with hazardous waste mismanagement, particularly as this mismanagement relates to smaller quantity generators. This program requires all of the 67 counties in the State of Florida to conduct assessments of hazardous waste-related activities in their jurisdictions, according to guidelines developed by the State of Florida. One component of the county assessments consists of a survey of hazardous waste generators. These generators were identified using a list of approximately 400 industries. This list was initially assembled by the Office of Solid Waste, U.S. EPA for use in its national survey of small quantity generators and was subsequently expanded to include firms that are of particular significance to the State of Florida (e.g., Boat Building and Repair), as well as to include those firms that are involved with the production of waste oil. Even though waste oils are not regulated as a hazardous waste, they were included in the State of Florida county surveys because of possible future regulation. These data will help to define the problems associated with hazardous waste disposal in sanitary landfills, as well as problems associated with other management methods used by small quantity generators of hazardous waste. In addition, these data can provide information that can be used in determining the future regulatory status of waste oil.

The data in this study relating to sanitary landfills are for the 160 landfills that are in use in the State of Florida (i.e., permit status: active) and of Class I, II, or III. Sanitary landfill facility classes in the State of Florida are defined as follows:

Class I Landfill	Landfill receiving some putrescible waste or garbage with total disposal in excess of 20 tons or 50 cubic yards (compacted) per day. Daily cover is required.

Class II Landfill	Landfill receiving some putrescible waste or garbage with total disposal of less than 20 tons or 50 cubic yards (compacted) per day. Minimum cover is once every four days.
Class III Landfill	Landfill receiving only non-putrescible waste (i.e., trash, demolition and construction debris, yard trash, etc.). Minimum cover requirement is once per week.

There are (93) Class I facilities, (27) Class II facilities, and (40) Class III facilities in the State of Florida. Thirty counties have only one active, permitted facility, while nine counties have between 5-8 facilities. The remaining 28 counties in the State of Florida have between 2-4 facilities. Most of the facilities are publicly-owned and operated and have either no liner or a clay liner. On the average, each of these facilities serves a population of approximately 100,000 people; is between 80-120 acres in size; has a cell depth of 12 feet; has a depth to water table of 20 feet; has a soil permeability of 18 inches per hour; has 6 groundwater monitoring wells and 2 surface water points; and has adjacent land that is agricultural.

Table 1 shows the amount (by weight) of hazardous waste reported generated annually in the State of Florida for the major types of waste generated. These include: waste oils and lubricants; lead-acid battery waste; heavy metal waste; spent solvent waste; acidic or alkaline waste; and photographic waste. Approximately 85% of the total waste reported generated per year in the State of Florida is contained in these six waste types.

TABLE 1

Major types of waste and amounts reported generated annually in the State of Florida

Types of waste generated	Amount generated (metric tons per year)	% of total waste generated
Waste oils and lubricants	41,330	35
Lead-acid battery waste	16,675	14
Heavy metal waste	16,464	14
Spent solvent waste	12,130	10
Acidic or alkaline waste	9,963	8
Photographic waste	5,515	5

Table 2 shows some of the practices reported used to manage the wastes shown in Table 1. The waste management practices that were primarily used include: recycling; sanitary landfill; public sewer; and filtration. Approximately 70% of the total waste generated per year in the State of Florida is managed using these four management methods.

TABLE 2

Primary waste management methods used

Management method used	Amount (metric tons per year)	% of total waste generated
Recycling	41,562	36
Sanitary landfill	26,775	23
Public sewer	10,403	9
Filtration	4,349	4

Table 3 shows the amount (by weight) of hazardous waste reported disposed annually in sanitary landfills in the State of Florida for the major types of waste generated. These include waste oils and lubricants; heavy metal waste; lead-acid battery waste; spent solvent waste; and acidic or alkaline waste. These five waste types represent approximately 85% of the total waste reported disposed in sanitary landfills.

TABLE 3

Major types of waste and amounts reported disposed annually in sanitary landfills in the State of Florida

Types of waste disposed in sanitary landfills	Amount (metric tons per year)	% of landfilled waste
Waste oils and lubricants	12,108	45
Heavy metal waste	3,557	13
Lead-acid battery waste	3,101	11
Spent solvent waste	3,002	11
Acidic or alkaline waste	985	4

Table 4 shows the amounts of hazardous waste reported generated by selected industries in the State of Florida. The industries contributing the most tonnage in the study area are: automotive repair shops; gasoline service stations; automotive and home supply stores; electronic components; and photofinishing laboratories. Approximately 40% of the total waste generated per year is from these five industries.

TABLE 4

Amount of waste reported generated annually by selected industries

Industry	Amount generated (metric tons per year)	% of total waste generated
Automotive repair shops	18,404	16
Gasoline service stations	13,121	11
Automotive and home supply stores	7,866	7
Electronic components	5,015	4
Photofinishing laboratories	3,066	3

ENVIRONMENTAL EXPOSURE ASSESSMENT

This study has identified the types of wastes reported disposed in sanitary landfills in Florida by small quantity hazardous waste generators. As a result of the possibility that these wastes may contaminate water supplies, efforts are being directed toward assessing the potential for exposure to these wastes. In addition, the siting of new facilities (sanitary landfills) in certain locations may have the potential for increasing the environmental area at risk, due to the specific hydrogeological characteristics at a particular site. As a result, the development of procedures for monitoring sites located in sensitive environments (such as wetlands) is necessary in order to detect contaminant migration from these facilities. These monitoring procedures should take into account the diverse nature of wastes present in sanitary landfills, a diversity which is due, in part, to the wastes produced by small quantity generators.

Contaminants which are present in the leachate from sanitary landfills pose potential risks to human beings from a variety of exposure routes. These risks may be expressed as a relationship between the intrinsic toxicity of the compound and the exposure circumstances. For contaminated groundwater, the potential routes of exposure include: direct ingestion of water; ingestion of fruits and vegetables which have been irrigated with contaminated water; dermal

exposure via showering, bathing, swimming or ancillary activities; and inhalation exposure from the release of volatile organic compounds into the atmosphere. In addition, many contaminants, particularly organic solvents and metals, exhibit significant phytotoxicity and toxicity to aquatic or terrestrial animal species.

RISK ASSESSMENT PROCEDURES

Procedures for the assessment of potential risk from contaminants in groundwater may be divided into two functionally important classifications: those for carcinogenic compounds and those for non-carcinogenic compounds. The difference between these two procedures is due to the fact that non-carcinogenic compounds typically do not exert toxic effects below a threshold dosage. Due to this threshold phenomenon, it is often possible to establish acceptable levels for human exposure based on animal data or epidemiologic evidence (ref. 2). Current risk assessment procedures (ref. 3) for carcinogenic compounds are based on numerical or statistical likelihood and are designed to estimate an exposure level, or Virtually Safe Dose (VSD), which is believed to be associated with an acceptable incremental risk level (e.g., 10^{-6}).

In order to assess the risks posed by individual contaminants which may be contained in small quantity generator waste disposed in sanitary landfills, a thorough review of the pertinent toxicological literature should be performed for a compound, and a profile of the toxicant developed. This profile can then be used to derive a Recommended Protective Concentration (RPC) for the compound. In the case of compounds which are judged to exhibit a carcinogenic potential, the Linearized Multistage Model (ref. 4) can be applied to appropriate bioassay data and an Acceptable Daily Intake (ADI) can be estimated, typically representing the intake associated with an estimated risk level of 10^{-5} or 10^{-6} (ref. 5). In the case of non-carcinogenic compounds, an ADI is established by first identifying a No-Observable-Adverse-Effect-Level (NOAEL) from appropriate animal data. Subsequently, an acceptable human exposure level can be estimated by converting the animal intake data to an equivalent human intake value. If adequate information is available, additional refinements may be accomplished by incorporating data on the pharmacokinetics of the compound. Finally, depending upon the quality of the available data, an uncertainty factor is applied to account for uncertainties in the process of extrapolation from animal species to man.

The small quantity generator hazardous waste study described in this paper has identified specific classes of wastes (e.g., solvents, photofinishing wastes, and waste oils and lubricants) which pose a potential threat to the groundwater

in Florida. Systematic risk assessments, as described above, have been performed for over 40 of the components of these waste streams in order to better quantify the potential environmental or human health hazard posed by wastes disposed in sanitary landfills or by using other management methods that may lead to the contamination of water supplies.

RESULTS AND CONCLUSIONS

The data presented in this paper were collected from approximately 20,000 small quantity hazardous waste generators located throughout the State of Florida. These data indicate that over 117,000 metric tons of small quantity generator waste is reported produced each year in Florida. Of this waste generated, 23% is reported disposed in sanitary landfills in the State. This small quantity generator hazardous waste that is deposited in these landfills has the potential for adversely affecting the water quality of the State of Florida by contaminating the environment and entering the ground or surface waters.

The environmental exposure assessments that have been conducted for many of the compounds that are found in these small quantity generator wastes, indicate that a relatively small quantity of some compounds can lead to a contamination level that may be of concern. For example, the halogenated solvent 1,1,2,2 - tetrachloroethane, a common constituent of many cleaning fluids, has been shown to exert both carcinogenic and non-carcinogenic effects at low concentrations. Based on an extrapolation from animal studies and human epidemiological data, a Recommended Protective Concentration (RPC) of 1.3 micrograms per liter has been proposed to correspond with an estimated risk level of 10^{-6} (ref. 6). In contrast, for phenol, a compound which has not been shown to exert carcinogenic or mutagenic effects, an RPC of 1.8 milligrams per liter (1,800 micrograms per liter) has been proposed (ref. 6). Yet phenol is detected by taste and smell for many individuals at a concentration of considerably less than 1 milligram per liter. This emphasizes that degradation of water supplies may involve organoleptic or other considerations apart from strict toxicity concerns.

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